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A TEST OF MESSAGE DIFFUSION BY CHAIN TAGS[1]

STUART C. DODD

ABSTRACT

A new instrument, "chain tags," has been devised for getting measurable data on message diffusion. A dramatic and controllable method of starting the diffusion process, it can isolate, vary, or hold constant the maximum for each of the following variables, alone or in combination as desired: number of starters; number of eventual hearers; the acts-per-actor-per-remove or period; the total period, area, and population within which diffusion takes place; the number of removes; the interperson distances and periods. This study illustrates the usefulness of the chain-tags technique in testing a theoretical model of one-way human interacting and comparing the strength of different motivations to diffuse a message.

I. THE PROBLEM—TO PRODUCE AND TRACE DIFFUSION

The Washington Public Opinion Laboratory studied the problem of diffusing a message through the population of a given community and then tracing its diffusion.[2] It was found that, faced with the necessity of starting "rumors" which were both true and of intrinsic interest, the well-organized media of communication of the American public made it difficult to perform the task. Newsworthy items were soon picked up by existing mass media, leaving only relatively uninteresting material or material of interest to only a few people to be passed on through informal diffusion. Getting purposive messages to spread widely in whole communities in the absence of any felt need for them was a difficult problem.

One type of message was found to have considerable appeal. This particular message concerned a coffee slogan, knowledge of which entitled the housewife to a free pound

[1] "This research was supported in part by the United States Air Force under Contract AF 33(038)-27522, monitored by the Human Resources Research Institute (now, Officer Education Research Laboratory, Air Force Personnel and Training Research Center), Air Research and Development Command, Maxwell Air Force Base, Alabama. Permission is granted for reproduction, translation, publication and distribution in part and in whole by or for the United States Government." For fuller description of the project see S. C. Dodd, "Testing Message Diffusion from Person to Person," *Public Opinion Quarterly*, Vol. XVI (spring, 1952). More detailed reporting may be secured in mimeographed form on application to the Public Opinion Laboratory.

[2] This study of diffusion is part of the laboratory's systematic testing of the interactance hypothesis, factor by factor, under controlled conditions (see S. C. Dodd, "The Interactance Hypothesis—a Gravity Model Fitting Physical Masses and Human Groups," *American Sociological Review*, Vol. XV, No. 2 [April, 1950]; and *Systematic Social Science* ["American University of Beirut, Social Science Series," No. 16 (Seattle: University of Washington Bookstore, 1947)], pp. 547 ff.).

The interactance hypothesis expects high correlation between a human interactivity to be predicted and a predictive "index of interactance." This index is defined as a product of the following relevant factors, each weighted by its exponent:

$$[I_{pp} \overset{\text{def.}}{=} kP_1^pA_1^aP_2^pA_2^aV^vT^tL^lC^c], \qquad (1)$$

where

I_{pp} = The interactance index
= is defined as a weighted product of
k = a constant (to adjust units),
P_1^p = the actors,
A_1^a = their acts,
P_2^p = the reactors,
A_2^a = their reacts,
V^v = the conceptual stimuli or "values,"
T^t = the timing,
L^l = the spacing,
C^c = and other residual known conditions.

In our Pretest M on chain tags, the actors are givers of a packet, each act is giving a packet, the reactors are receivers of packets, and each react is one receipt; the values were the four motivations or verbal stimuli of Exhibit A; the timing was in ordinal units of removes; the intervening distances were neglected (i.e. $(L^l)^0 = 1$), and the conditions seemed otherwise fairly constant among the actors (i.e., $C^0 = 1$).

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of coffee. Costs of the research were split between the coffee concern and our research organization, so that no advertising for this brand was paid for from our tax-supported funds. Nevertheless, there was criticism of this link to a commercial venture, and we decided not to repeat this type of message in our later research. On the other hand, messages which were of a civil-defense variety or of some equally socially approved nature were found to have little potency unless reinforced by dramatic means of starting the diffusion process. In one town, in the course of a previous study, a message was started with just one person. A later survey revealed that the original starter was the only person in the community who knew the message.

A second technical problem was to observe exactly the diffusing of any message. We needed to learn the mechanism: who tells what to whom, when and where, why and how? If such questions are asked in a census poll later, the memory error is large. Some device was needed to record each interact fully and as it occurred, without impeding the diffusing.

Therefore, the problem was to devise a measuring instrument and a means of starting the process of message diffusion which could give reliable and valid data and motivate the American population in peacetime to pass on the message quickly to a majority of the population. Such an instrument, the result of some dozen trials of different techniques, is described in this paper. It was developed to permit control over the number of message knowers, the number of removes (links) from the message starter, the activity rate or hearers-per-teller ratio, and the amount of time during which and the area and population in which the message diffusion took place. Any technique through which the experimenter can control (by the printed instructions he gives or by other action) the number of tellers, hearers, tellings, and their time and space intervals would help to answer the substantive questions of this "Project Revere." These questions were such as: How *fast* will a given message spread under specifiable conditions? How *far?* How *fully* through all the population? How *faultlessly?* How *effectively* in stimulating specified complaint responses?

II. ONE SOLUTION—CHAINS OF TAGGED MESSAGES

One technique, named "Chain Tags," was found to fulfil all the requirements necessary. A chain tag is a cellophane-wrapped pack of identical postcards given to each of several starters in each of several communities. Each starter received a pack of ten postcards, opening to a subpack and a "tracer" card, which gave instructions and asked a few questions. The remaining subpack of nine identical cards in a single cellophane wrapping was to be passed on to anyone. The second person in the chain responded to a tracer card and passed on a subpack of eight. In this way each recipient gave away his one subpack and mailed in one filled-out tracer card. The tracer cards recorded the names and addresses of the givers and receivers, as well as the times and places of transfer and certain background data.

In the pretest of the new instrument, four communities were roughly matched on ecological and demographic variables recorded in the 1950 Census and in respect to their general economy and local history. Matching consisted of asking judges with the census and other data before them to choose the four most similar towns from the list of all towns in the state. Each of these four matched communities had approximately 1,000 population. Ten message starters, in each of the four towns, were the first links in the chain of ten card-receivers. The starter pack was delivered by a member of the Washington Public Opinion Laboratory staff to one person in each town in each of ten different occupations. The occupations and their representatives were chosen by a set of rules so as to be present in most towns. The occupations were (1) news editor, (2) town clerk, (3) seventh-grade teacher, (4) druggist, (5) grocer, (6) minister, (7) bartender, (8) realtor, (9) postmaster,

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(10) barber. A minimum of explanation was given to each starter, his attention being directed to the instructions on his tracer card (see Exhibit A). These printed instructions were thus constant throughout this given chain. However, supplementary forms of stimulation, such as person-to-person comments as the cards moved through the chain, were not controlled.

III. AN EXPERIMENT—COMPARING FOUR MOTIVATIONS

A different message was printed on the card in each of the four towns (see Exhibit A). The message included one of the following appeals: (1) "Help Civil Defense," (2) "Help Scientific Research," (3) "Help Paul Revere" (this is a strengthened civil-defense appeal asking for modern Paul Revere techniques of passing on messages when no other means of communication is available), and (4) "Earn a Dollar." In the last of these four motivational appeals, when the tracer card, with prepaid postage, reached the laboratory, a dollar was delivered to the card sender.

Figure 1 and Table 1 show the distribution of returns by type of motivation and by removes. Forty per cent of the 400 cards given to 40 persons as starters were returned by mail by their 161 receivers, as requested on the card. This was a remarkably good showing in a peacetime situation asking for only voluntary co-operation.

The "Help Paul Revere" message, a modern civil-defense theme, netted the greatest return, with 55 per cent of the total number of cards sent in to the laboratory. It had the largest number of effective starters and a "compliance ratio" of 0.88. This means that at least 88 per cent of its receivers complied with instructions in passing the subpack on and mailing in the tracer card. (A few more may have passed on their subpacks, but if the recipients then failed to mail in their tracer cards, we would have no proof of it.) The dollar message had the greatest persistence, i.e., a higher compliance ratio of 94 per cent, with the largest number of complete packs of all ten links or removes returned. However, only half the original starters complied with the instructions. These two messages ("Help Paul Revere" and "Earn a Dollar") were the most effective in motivating the population to pass on the chain tags. The patriotic appeal was superior to the commercial appeal both because of its swifter and larger total response and because of its lower cost in money and administrative effort. The fact that only one community was used for each motivation allows unknown differences between communities, not used in matching, to have an effect. Therefore, these results can be consid-

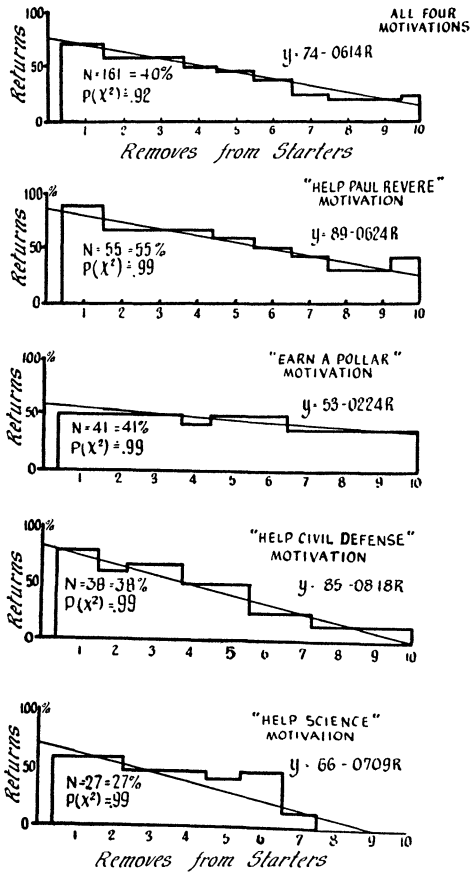

FIG. 1.—Per cent returns by removes. Fitted t straight-line trend for each of four motivations i four matched communities, showing that return tend to wane with removes, i.e., diffusing decreases with time (in ordinal units).

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ered only tentative until checked in at least one other set of matched communities.

Analysis of the time of giving and getting the chain tags, as noted on the tracer cards, showed that the median time taken to pass on the subpacks to a different household was 14 minutes. For the "Help Paul Revere" motivation this median time was only 10 minutes. This illustrates the ability of the chain-tags technique, given *some* effective motivation, to pass rapidly through a population which is not directly concerned with message diffusion. The speed of transmission indicates that most persons allowed message diffusion to take precedence over their activity of the moment.

As might be expected, the later removes or links in the message chain usually take longer from the starting point than do earlier removes. However, analysis reveals that certain later-remove chains were quite fast, apparently because of the high degree of motivation of the starters. There is some evidence that remove time, if measured in clock units, i.e., the time for new links to form, varies with the kind of message. The dollar theme links were slow in forming, yet sure.

IV. THE GEOMETRIC GROWTH HYPOTHESIS TESTED

A hypothesis to be tested on the amount of compliance in the chain-tags experiment was the simple geometric series,

$$S = \frac{n\,[1 - (a\,b)^{r}]}{1 - a\,b}, \qquad (2)$$

where S = total cards returned before deadline; n = number of starters; N = total number of possible returns; a = number of subpacks in each pack (=1 here); b = S/N = response level, i.e., proportion of returns; ab = average hearers-per-teller ratio; r = average number of removes = total number of transfers recorded ÷ number of starters if $a = 1$. This hypothesis was found to be inadequate for this experiment.

The definition of a remove in terms of average response per pack treats a remove as simply a function of response. The average response per pack was four, but there were ten removes observed in all but the case of "Help Research," where there were seven removes. Finally, and very important, no provision was made for ineffective starters, i.e., packs for which there were no observed removes.

TABLE 1

OBSERVED AND EXPECTED FREQUENCIES FROM GEOMETRIC SERIES MODEL BY REMOVE AND BY MOTIVATION

Remove i =	All Motivations		"Civil Defense"		"Help Research"		"Help Paul Revere"		"Get a Dollar"	
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Total.....	161	170	38	41	27	26	55	66	41	42
1.....	28		8		6		9		5	..
2.....	23	25	6	7	5	5	7	8	5	5
3.....	23	22	7	6	4	4	7	8	5	5
4.....	20	19	5	5	4	3	7	7	4	4
5.....	19	17	5	4	3	3	6	7	5	4
6.....	16	15	2	3	4	2	5	6	5	4
7.....	10	13	2	3	1	2	4	6	3	4
8.....	7	12	1	2	..	..	3	5	3	4
9.....	7	10	1	2	..	..	3	5	3	4
10.....	8	9	1	2	..	..	4	5	3	3
Correlation of expected with observed (uncumulated)....	.96		.93		.78		.91		.82	

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In the light of these deficiencies, a new geometric series model was set up, in which b was redefined as the average proportion of response by each remove. Thus the b for a given remove, b_i, will be defined as a fraction whose numerator is the frequency of returns for the ith remove and whose denominator is the frequency of the ith $-$ 1 remove. The average percentage from the second to the last remove will be taken as b. The first remove is not included, because the average percentage of returns is not intended to include ineffective or inactive starters, only effective starters. Also n, as redefined, is the number of original starters who were active and is represented by the number of first-remove cards returned. The total number of removes, r, as redefined, is the number of removes, excluding the first, from which at least one card was returned. Thus there now are nine removes, except in the case of the "Help Research" motivation, where $r - 1 = 6$.

An attempt will be made to fit this geometric model, stochastically, remove by remove, not in terms of calculating the end result in one step. The expected frequency for each remove in turn will be compared to the observed frequency:

$$S_i = \frac{n\,[1 - (a\,b)^{\,i-1}]}{1 - a\,b}. \qquad (3)$$

Table 1 gives the observed and expected frequency by removes and motivations for each motivation and for all cases taken together. The same material is presented in graphic form in Figure 1.

A preannounced standard for a satisfactory descriptive closeness of fit of the expected distribution to the observed data was a correlation coefficient above .90. Inspection of the last row of Table 1 shows that the correlation coefficients of the expected and observed data in the uncumulated data were quite high. Two of the four r's for separate motivations passed our arbitrary standard of $r > .9$, while two did not. The combined closeness-of-fit correlation coefficient was .96 in uncumulated data when using all forty original starters and their chains (see Fig. 2). The corresponding intraclass correlation was .91. One might conclude, therefore, that this high correlation showed that the data as a whole indicated the geometric series to be a satisfactorily close descriptive fit in the situation studied.[3] Alternative models were set up

[3] Alternative descriptive indices of fit are possible, of course. Thus the intraclass correlation is a more exacting descriptive measure of close fit than the Pearson correlation coefficient. The latter measures agreement in ranking, the cross-product moment, while the former also measures agreement of means and variances between the model and the data.

The fits for b and c and in Fig. 1 were determined by least-squares techniques. Of the ten observed points, two degrees of freedom were absorbed by either model b or model c, and two further degrees were absorbed by the correlation coefficient, leaving six degrees of freedom. The fit for a was made recursively point by point, using eq. (3) as stated in the text. This was done to explore the adequacy in these data of the reasoning underlying this geometric series model, even though it left no degrees of freedom to permit estimating to further sets of data by chi square or other tests of statistical significance. Consequently, chi squares are reported (as in Fig. 1) for the linear arithmetic series but not for the geometric series here. Even for the linear series in Fig. 1, however, the chi square is of dubious applicability. For there may be correlations between the increments in successive removes, making the observations in these time series depart from the assumption of independence to an unknown extent.

Similarly, the tests of statistical significance of the r (or of the z test when r is near unity and based on few cases, as here) seemed not strictly applicable. They were computed as an indication and suggested that these high r's are significantly different from zero at the 5 per cent level. But we do not know how much this test was distorted because our data did not fulfil the assumption of normality.

Our general conclusion on significance tests here was that better experimental data are more needed than shopping around among parametric and non-parametric tests. Developing the chain-tags technique seems to offer a way of collecting such data discriminatingly.

Figure 2 shows the fit of the data to the model in both cumulated and uncumulated form. The uncumulated data yield the most exacting test of fit and should be the form always reported. We record the cumulated data here also, however, because it is the form most often reported and used for comparison in previous studies. Its excess in closeness of fit over the uncumulated fit is spuri-

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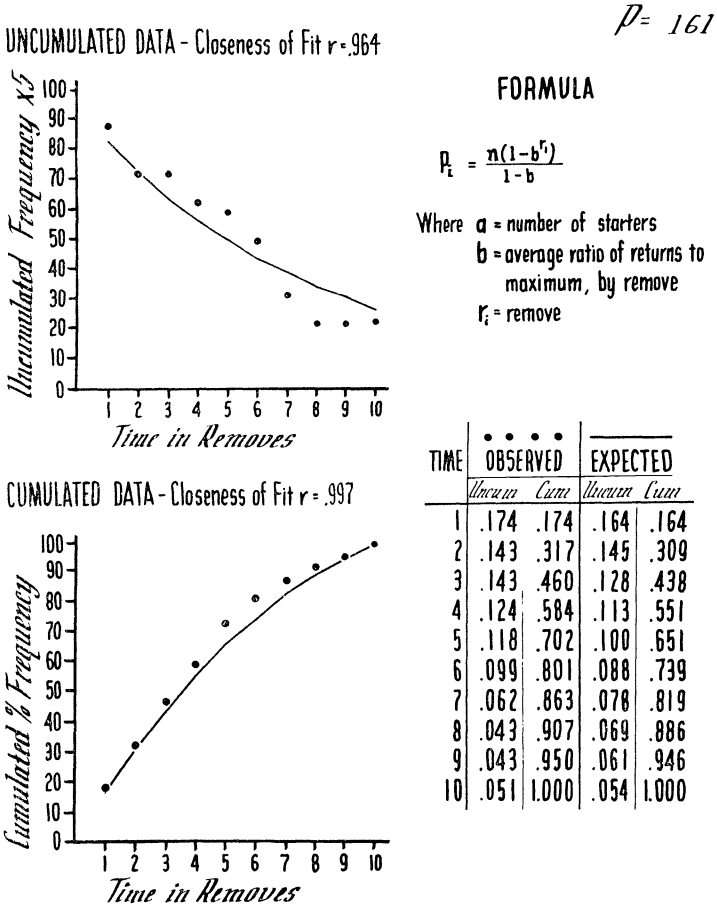
also. The results are given in Table 2.

We conclude, from Table 2, that, although the geometric model gives a close descriptive fit to the observed uncumulated frequencies of compliance, alternative models fit as well. It is a task for further research, using a larger number of starters, to determine which of these models gives the best results. There is nothing to choose between them on the grounds of parsimony. There seemed no firm preference among them on the basis of statistical significance. On grounds of empirical experience, the harmonic logistic fitted markedly better in many diverse tests in "Project Revere." Additional data and differential designs are needed for determining which is the best model under specified conditions for scien-

ous, since even random data will show good fits when cumulated if the range be large and the class-intervals numerous.


UNCUMULATED DATA - Closeness of Fit r=.964
Uncumulated Frequency %
Time in Removes
CUMULATED DATA - Closeness of Fit r = .997
Cumulated % Frequency
Time in Removes
FORMULA
$P_t = \frac{a(1-b^{r_t})}{1-b}$
Where a = number of starters
b = average ratio of returns to maximum, by remove
r_t = remove

TIME	OBSERVED		EXPECTED	
	Uncum	Cum	Uncum	Cum
1	.174	.174	.164	.164
2	.143	.317	.145	.309
3	.143	.460	.128	.438
4	.124	.584	.113	.551
5	.118	.702	.100	.651
6	.099	.801	.088	.739
7	.062	.863	.078	.819
8	.043	.907	.069	.886
9	.043	.950	.061	.946
10	.051	1.000	.054	1.000

$P = .161$

FIG. 2.—Test of geometric series hypothesis. Message diffusion by chain tags with four motivations in four towns.

TABLE 2

Model	Correlation of Model with Observed Data (in Uncumulated Data)	
a) Geometric series	.96	(intraclass $r = .91$)
b) Harmonically waning logistic	.97	
c) Arithmetic series	.95	

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tific research in this area. The chain-tags technique offers a way of testing a wide range of models with high control of the experimental factors.

V. SUMMARY

This chain-tags technique for getting measurable data in a controlled experiment on social interaction in the form of all-or-none message diffusion promises to be a highly effective new instrument for social research. Tagged messages *can* be passed to order, rapidly and widely, through a small American community. The large percentage of compliance (40 per cent) justifies the use of this method.

The results also have substantive implications. The "Paul Revere" theme, appealing to the patriotism of the American public, stood out here as the most effective of the four themes in eliciting the largest number of returns and the largest number of effective starters. The dollar theme demonstrated more persistence, as shown by longer chains. However, the administrative difficulty and expense counteract this advantage. The indication from this pretest is that the patriotic appeal, under these message-diffusion conditions, is quite satisfactory in getting a message passed on fast, faultlessly, and effectively. The "Paul Revere" message diffused fast in taking a median of 10 minutes from hearing to retellings. It diffused faultlessly by being a printed leaflet which lost nothing as it passed on from person to person. It diffused effectively to the extent that 55 per cent of the leaflets reached persons who complied with their instructions to mail back the tracer postcards.

UNIVERSITY OF WASHINGTON

EXHIBIT A

"TRACER" POSTCARDS WITH FOUR MOTIVATIONS

1

"Help Civil Defense"

We Want Your Help in Studying How News Travels from Person to Person

We are trying to find out how news gets around without the aid of newspapers, radio or telephone. In time of extreme emergency there might be no other way to get instructions to the public. Civil Defense agencies will be grateful for your help. When you opened the pack given to you, you found this card and a smaller pack. Please:

(1) PASS ON the smaller pack to someone outside your own household who you believe will also be willing to help us.
(2) FILL IN all of the other side of this card.
(3) MAIL US the card by June 1, 1952. No postage required.

Passing on every pack is essential for this Civil Defense test of how a vital message could be got to everyone in an emergency.

2

"Help Research"

University of Washington

THIS IS PART OF A RESEARCH STUDY IN PERSON-TO-PERSON COMMUNICATION BEING CONDUCTED BY THE UNIVERSITY OF WASHINGTON. It may appear puzzling, but it really is a scientific experiment and has nothing to do with advertising. When you opened the pack given to you, you found this card and a smaller pack. Please:

(1) PASS ON the smaller pack to someone outside your own household who you believe will also be willing to help us.
(2) FILL IN all of the other side of this card.
(3) MAIL US the card by June 1, 1952. No postage required.

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Check on the enclosed postcard if you would like an explanation of this experiment sent to you. Thank you for your cooperation.

3

"Help Paul Revere"

PAUL REVERE may have to ride again with a vital message if bombs ever fell near here.

YOU may be asked to carry that message.

THIS card is a TRACER MESSAGE testing how well you and other citizens can pass on a defense message, so that vital news will reach every living person in this community if radio, newspapers and telephones were all knocked out.

YOU and some of your fellow citizens are being asked to make this study in Tenino (Wash.) for the nation. Your part of this test is to pass on the enclosed message-packet and record your part of its path from person to person through Tenino.

OUR Civil Defense authorities need to learn just how best to communicate life-saving messages to everyone in an emergency (however unlikely we all hope that may be).

TO HELP any future Paul Revere, *Please:*

(1) Give the enclosed message-packet to someone else.
(2) Mail this card, filled out, back to us by June 1, 1952.

4

"Earn a Dollar"

We Will Pay You One Dollar for Your Help in a Study
of How News Travels from Person to Person

We are trying to find out how news gets around without the aid of newspapers, radio or telephone. When you opened the pack given to you, you found this card and a smaller pack. Please:

(1) PASS ON the smaller pack to someone outside your own household who you believe will also be willing to help us.
(2) FILL IN all of the other side of this card.
(3) MAIL US the card by June 1, 1952. No postage required.

When you send in your card the person who gave you your pack gets a dollar. In the same way, you get your dollar as soon as the person you give the smaller pack to sends in his card as a receipt with your name on it.

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